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Hukker, Vera; Hendriks, Petra

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Whose side are they on? Children's interpretation of perspective-dependent prepositions

Vera Hukker and Petra Hendriks
University of Groningen

Spatial prepositions express relations between objects in space. A subset of spatial prepositions is ambiguous due to the different perspectives from which these spatial relations can be considered. The ability to consider another person's perspective is still developing in children. This study investigates how Dutch-speaking children (mean age 10;1) and adults interpret perspective-dependent spatial prepositions uttered by a speaker. We found that adults took the speaker's perspective in a third of the cases, whereas children did so in a sixth of the cases. No differences in interpretation emerged between prepositions in assertions and requests, although these different speech acts reflect different speaker intentions. In general, children performed like adults, but less often took the speaker's perspective with *naast* compared to *voor* and *achter* in assertions. We conclude that 10-year-olds can take another person's perspective when interpreting spatial prepositions, but, like adults, only do so in a minority of cases.

Keywords: Language development, perspective-taking, egocentric perspective, other-centric perspective, reference frame, spatial prepositions

1. Introduction

1.1 Point of view in space

For many communicative tasks, we must choose a point of view in space to talk about the spatial relations between objects. This is needed for purposes such as describing a route ("take the first left"), communicating locations ("the scissors are in the drawer"), and assembling furniture ("fasten the legs to the frame"). In particular, we must choose a point of view in space when we use or interpret spatial expressions (Bullens, Lienenkämper, Wijnen, and Postma, 2013), such as the spatial prepositions *in front of* and *behind*. Such a point of view in space is called a *reference frame*

(RF). Levinson (1996, 2003) distinguishes three types of RFs: a relative frame (which relates the locations of objects to the perceiver), an intrinsic frame (which takes the perspective of one of the objects and relates the locations of other objects to it), and an absolute frame (which uses a fixed point of view in space). In this study, we investigate the choice between two distinct relative frames, namely an egocentric relative frame (relating objects to the self, in our study: the listener) and an other-centric relative frame (relating objects to the communicative partner, in our study: the speaker).

1.2 Interpreting spatial prepositions

When communicating with a partner, it is not only necessary to choose an RF, but also to know which RF the communicative partner chooses. This knowledge is crucial for understanding perspective-dependent spatial prepositions such as *in front of* and *behind*. Imagine person A and person B, facing each other with a bottle and a cup in between them. When person A describes the bottle as being behind the cup, the question is whether person A described the situation from his own, egocentric perspective, or from person B's perspective. If person A described the situation from an egocentric perspective, the description will be correctly interpreted by person B only if person B takes an other-centric perspective. If person A described the situation from an other-centric perspective, the description will be correctly interpreted by person B only if person B takes an egocentric perspective. Without clarifying which perspective a listener should take, spatial prepositions such as *in front of* and *behind* are ambiguous and can be misunderstood.

The ambiguity arises because *in front of* and *behind* are so-called *projective locative prepositions*: they require spatial information about the location of the objects as well as information about the direction of the relation from one object to the other (Zwarts and Winter, 2000). The direction of this relation can change with the perspective taken by the speaker. The interpretation of these prepositions therefore depends on the listener's assessment of the perspective taken by the speaker, and on the listener's ability to interpret these prepositions from this perspective. Thus, the interpretation of projective locative prepositions is challenging in two ways: because of the ambiguity of these prepositions due to the different perspectival possibilities, and because the listener must assess and subsequently adopt the perspective taken by the speaker.

1.3 Other-centric perspectives with spatial prepositions

Although humans are able to apply different RFs, they are egocentrically biased: they first consider the world from their own perspective. If an other-centric perspective needs to be taken, the initially egocentric perspective will have to be adjusted (Epley, Morewedge, and Keysar, 2004; Keysar, Barr, Balin, and Brauner, 2000), which requires mental effort (Epley et al., 2004; Duran, Dale, and Kreuz, 2011). Thus, it is expected that when there is a choice between taking an egocentric and an other-centric perspective, such as with projective locative prepositions, people take their own perspective.

However, Tversky and Hard (2009) found that their participants took an other-centric perspective in about a quarter of cases when describing spatial relations between objects. Participants had to answer questions about relations between objects lying on a table, such as “In relation to the bottle, where is the book?”. At the other side of the table another person was visible, but no explicit instructions were given about which perspective to take. Tversky and Hard’s results imply that the mere presence of another person can already lead to other-centric productions. In addition, Tversky and Hard investigated what happened if the other person reached for an object, and if attention was called to this action by asking “In relation to the bottle, where does he place the book?”. In these situations, the amount of other-centric productions increased significantly. In a web-based experiment by Duran et al. (2011), participants were listeners instead of speakers and had to hand over a specific folder from multiple folders on a tabletop visible on their computer screen in response to instructions like “Give me the folder that is on the right”. The location of the participant and the virtual speaker were also visible on the computer screen. Again, no instructions were given about which perspective to take. About 52% of the participants took the other-centric perspective. When being informed that the virtual speaker actually was a real person, this was still 29%. This shows that people adopt other-centric perspectives also when there is ambiguity with respect to the perspective to be taken.

So adults frequently adopt an other-centric perspective in their production (Tversky and Hard, 2009) and interpretation (Duran et al., 2011) of spatial expressions, even though they could have adopted an egocentric perspective. Is such other-centric perspective-taking behavior already present early on, or do children need to develop the ability to take an other-centric perspective in language, as they do in the visual domain (Flavell, Everett, Croft, and Flavell, 1981) and the cognitive domain (see the extensive literature on Theory of Mind development)? Furthermore, do

listeners only adopt an other-centric perspective when they act upon instructions by a speaker, as in Duran et al.'s study, or do listeners also adopt an other-centric perspective if the speaker merely describes a spatial configuration to the listener? These tasks would involve different speech acts, namely a request in the former case and an assertion in the latter case. With a request, the speaker intends to elicit an action on the side of the listener, while with an assertion, the speaker intends to describe how things are and perhaps bring about a belief in the listener. Requests have a world-to-word direction of fit as they constitute an attempt to make the world match the words, while assertions have a word-to-world direction of fit as they constitute an attempt to make the words match the world (Vanderveken, 1998). Within the category of world-to-word speech acts, requests are listener-based and require an action by the listener, in contrast to for example promises, which are speaker-based (Vanderveken, 1998). Because requests are listener-based, it is conceivable that they invite less other-centric (i.e., speaker-centric) perspective-taking on the side of the listener compared to assertions, which are neutral in this respect.

1.4 Children's development of perspective-taking

During childhood, children develop the ability to take the visual perspective of someone else, which could be a prerequisite for taking the perspective of a communicative partner for communicative purposes. The development of visual perspective-taking is a two-level process (Flavell et al., 1981). At Level-1, children become aware that what another person is seeing can differ from what they see. At Level-2, children start to realize that, even if the object they see can be seen by someone else, the object may look different for the other person. So Level-1 perspective-taking is concerned with *what* other people see and only requires tracing a line of sight, whereas Level-2 perspective-taking is concerned with *how* they see it and requires a mental rotation to another perspective than one's own (Michelon and Zacks, 2006).

Different spatial expressions may require different levels of visual perspective-taking. According to Vander Heyden, Huizinga, Raijmakers, and Jolles (2017), the spatial prepositions *in front of* and *behind* can be processed by simply reversing the position of objects, for which Level-1 perspective-taking is sufficient. In contrast, for spatial expressions such as *left* and *right* a mental rotation is required, which requires Level-2 perspective-taking. Therefore, a further relevant question is how children interpret these different types of prepositions. In addition to children's development of the Level-1 type Dutch prepositions *voor* ('in front of') and *achter* ('behind'), we

investigate the Dutch preposition *naast* ('beside'). The interpretation of *naast* is the same for speakers and listeners situated across each other (at 180°), but taking the perspective of the speaker with *naast* requires a mental rotation by the listener if speaker and listener are situated at an angle of 90°.

The increased difficulty of *naast* compared to *voor* and *achter* also follows from the formal-semantic account of locative prepositions in terms of conceptual spaces (Zwarts and Gärdenfors, 2016). Zwarts and Gärdenfors (2016: 127) argue that *beside* has the basic meaning of spatial proximity (like *near*), and that its more restricted meaning ('near, but not above, behind, etc.') results from pragmatic competition with *above/below* and *in front of/behind*, possibly in the form of an implicature. Because of this additional pragmatic step in interpretation, *naast* ('beside') is expected to be more difficult to interpret than *voor* ('in front of') and *achter* ('behind').

1.5 The current study

The current study investigates children's interpretation of projective locative prepositions. The following three research questions are addressed: (1) How do children interpret these prepositions in perspective-taking situations, compared to adults? (2) How do listeners' interpretations differ in response to descriptions versus instructions given by a speaker? And (3) do listeners respond differently to the prepositions *voor* ('in front of'), *achter* ('behind'), and *naast* ('beside')?

2. Methods

2.1 Participants

57 monolingual Dutch-speaking children (32 girls) from two primary schools in Groningen and Gelderland participated in the study, with a mean age of 10;1 (age range 8;11-11;3). In addition, 28 Dutch adults (17 females), all (recently graduated) students from the University of Groningen, with a mean age of 23;0 (age range 18;7-27;0) participated as a control group. One adult was excluded after data collection because of familiarity with a similar task in a previous study.

2.2 Materials and design

To assess participants' perspective-taking behavior, three tasks were carried out. The Linguistic Description Task is a sentence-picture verification task, in which participants have to verify the

correctness of the speaker's description of a spatial configuration of objects. The Linguistic Instruction Task is an act-out task, in which participants have to act upon verbal instructions given by the speaker to place objects in a particular spatial configuration. The third task is a Visual Perspective-Taking Task, in which participants are asked how a particular spatial configuration is perceived from another perspective.

Linguistic Description Task – In this task, participants saw two objects in a particular spatial configuration on the computer screen. A giraffe, also visible on the screen, described the situation to the participant by uttering one of the following three types of sentences:

- (1) *De appel ligt voor / achter / naast de vlag*
'The apple is in front of / behind / beside the flag'

The giraffe was situated at either 180° or 90° from the participant (Figure 1). Participants were told that the giraffe was a bit confused and was not always right. If participants thought the description was right, they should press a green button on the keyboard, and if participants thought the description was wrong, they should press a red button. Half of the items matched the participant's perspective (egocentric) and half of the items matched the giraffe's perspective (other-centric). The task consisted of 24 experimental items (8 per preposition). In addition, 8 control items with the preposition *naast* were included in which the giraffe was situated at 180° from the participant, so the description would be correct from both perspectives. Items were randomized. Participants started with a pre-test consisting of 6 items without the giraffe being present on the screen (2 per preposition) to check the participants' understanding of the task and to verify whether they took an egocentric perspective.



Figure 1: A participant carrying out the Linguistic Description Task, with the giraffe situated at 180° (left) or 90° from the participant (right).

Linguistic Instruction Task – In this task, participants saw two objects on the left side of the computer screen. An owl, also visible on the screen, gave the participant instructions by uttering one of the following three types of sentences:

- (2) *Leg de appel voor / achter / naast de vlag*
 ‘Put the apple in front of / behind / beside the flag’

The owl was situated at either 180° or 90° from the participant (Figure 2). With the computer mouse, participants had to drag the two objects on the screen to a grid of four boxes in the middle of the screen to form the instructed configuration. Again, 24 experimental items and 8 control items were used. A pre-test consisting of 6 items preceded the experimental task, in which the owl was not present on the screen.

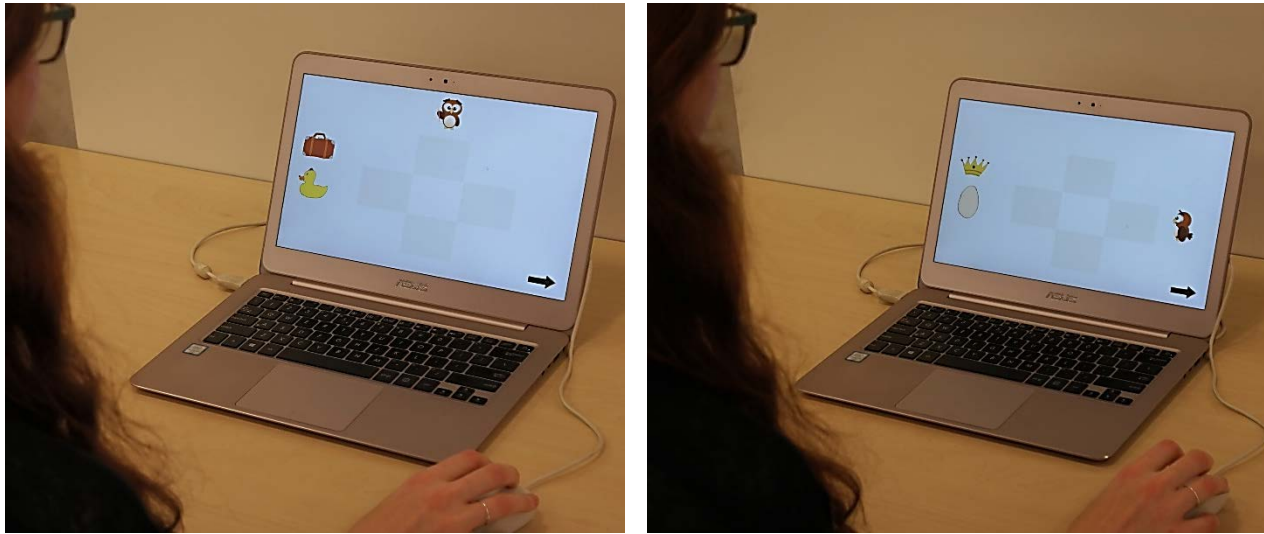


Figure 2: A participant carrying out the Linguistic Instruction Task, with the owl situated at 180° (left) or 90° from the participant (right).

Visual Perspective-Taking Task – To measure participants’ visual perspective-taking abilities, we adapted the Visual Perspective-Taking Task of Greenberg, Bellana, and Bialystok (2013) for Dutch. In this multiple choice task, participants were instructed to indicate which configuration of differently colored blocks in a four-block array showed what the owl was seeing from his perspective. The owl was situated at 90°, 180° or 270° from the participant. The experimental task was preceded by a round of three practice items, which participants could repeat to a maximum of two extra rounds to familiarize themselves with the task.

2.3 Procedure

All children were tested individually by the same experimenter in a quiet room at their school. Each test session took approximately 25 minutes. The order of the two linguistic tasks was balanced across participants. The Visual Perspective-Taking Task was always conducted at the end, to avoid priming effects on the linguistic tasks. Prior to each task, instructions were given by the experimenter and were also visible on the computer screen. Adults followed the same experimental procedure, and were tested in a quiet room at the University of Groningen. Adults read the instructions on the screen. In the linguistic tasks, no instructions about which perspective to take were given. For the Visual Perspective-Taking Task, we used the same procedure as Greenberg et al. (2013).

2.4 Data analysis

Accuracy data and reaction times were collected for all tasks. For this article, only accuracy data are analyzed. Answers on the Linguistic Description Task were scored as either egocentric or other-centric, answers on the Linguistic Instruction Task were scored as egocentric, other-centric or unclear, and answers on the Visual Perspective-Taking Task were scored as correct (other-centric), or incorrect, with errors being either egocentric, oriented (a correct front-back relation of blocks, but an incorrect left-right relation), or structured (a correct configuration of blocks, but represented from an incorrect perspective).

2.5 Inclusion criteria

The pre-test items in the two linguistic tasks were used to investigate participants' neutral RF when the speaker was not visible. Only participants who adopted an egocentric relative RF in this pre-test were included in our analyses, as the aim of the study is to see whether listeners take their own perspective (egocentric relative RF) or the speaker's perspective (other-centric relative RF). If listeners adopt another RF, for example an intrinsic or absolute RF (Levinson, 1996, 2003), it is impossible to determine which perspective they take on the test items. The inclusion criterion for participants was an egocentric response for at least 4 out of 6 pre-test items per linguistic task. In total 15 children (mean age 10;2, range 9;6-10;11) and 20 adults (mean age 23;3, range 18;7-27;0) remained. Of the 15 children, one was diagnosed with dyslexia, one with ASD, and one with ADHD.

Based on the pre-test results of the Linguistic Instruction Task, several participants were found to apply other than egocentric relative RFs: using a left-right axis with *in front of* being interpreted as *left* and *behind* as *right* or the other way around (adults: n=3, children: n=9), or a front-back axis with *in front of* being interpreted as further away and *behind* as closer to the body (children: n=13). In addition, there were participants who switched between RFs or whose RF was unclear (adults: n=3, children: n=19). One adult and one child applied an egocentric RF in the pre-test of the Linguistic Instruction Task, but did not do so in the pre-test of the Linguistic Description Task. By excluding participants who had a preference for a different perspective than an egocentric perspective on pre-test items, we ensure that the relevant choice for the remaining participants on the test items is between an egocentric perspective and the differing perspective of the speaker.

3. Results

Because of non-normally distributed data, nonparametric tests were used for analysis. All tests were run with and without the data from the three children with a clinical diagnosis (see Section 2.5), but no differences in the results on the linguistic tasks were found. Therefore, we decided to keep these three children in the analyses.

3.1 Linguistic Description Task

Wilcoxon signed-rank tests were used to investigate differences between egocentric and other-centric interpretations. Adults significantly less often took the other-centric perspective ($M=30.42$, $SD=39.88$) than the egocentric perspective ($M=69.58$, $SD=39.88$), $Z=-2.022$, $p=.043$. Children also significantly less often took the other-centric perspective ($M=15.00$, $SD=15.89$) than the egocentric perspective ($M=85.00$, $SD=15.89$), $Z=-3.376$, $p<.001$. A Mann-Whitney U test shows that the difference between other-centric perspective-taking of adults versus children is not significant, $U=141.5$, $p>.05$.

3.2 Linguistic Instruction Task

Wilcoxon signed-rank tests were used to investigate differences between egocentric and other-centric interpretations. The difference between adults' other-centric perspective-taking ($M=33.54$, $SD=47.30$) and adults' egocentric perspective-taking ($M=65.21$, $SD=48.65$) is not significant, $Z=-1.585$, $p>.05$. In 1% of the cases, the adopted perspective was unclear. Children significantly less often took the other-centric perspective ($M=13.61$, $SD=34.27$) than the egocentric perspective ($M=86.39$, $SD=34.27$), $Z=-2.931$, $p=.003$ ¹. A Mann-Whitney U test shows that the difference between other-centric perspective-taking of adults versus children is not significant, $U=128.5$, $p>.05$.

3.3 Visual Perspective-Taking Task

A Mann-Whitney U Test was used to investigate differences between adults' visual perspective-taking abilities and children's visual perspective-taking abilities. Adults' accuracy ($M=97.08$,

¹ Without the data of the three children with a clinical diagnosis, this difference was significant at p -level $<.05$ ($Z=-2.520$, $p=.017$).

$SD=5.59$) was significantly higher than children's accuracy ($M=85.00$, $SD=18.15$), $U=86.500$, $p=.033$. Three types of errors were made by children: oriented errors (56%), egocentric errors (33%), and structured errors (11%). Errors were made from the following angles: 180° (52%), 90° (26%), and 270° (22%). When excluding the data from the three children with a clinical diagnosis, the difference between the adults' accuracy ($M=97.08$, $SD=5.59$) and children's accuracy ($M=90.28$, $SD=12.22$) is not significant anymore, $U=83.000$, $p=0.082$.

3.4 Comparison between tasks

Wilcoxon signed-rank tests show that the difference between adults' other-centric interpretations in the description task ($M=30.42$) and the instruction task ($M=33.54$) was not significant, $Z=-.276$, $p>.05$. For children, this difference (description task: $M=15.00$, instruction task: $M=13.61$) was also not significant, $Z=-1.260$, $p>.05$.

3.5 Comparisons between prepositions

To investigate whether there are differences in interpretation between the three locative prepositions *voor*, *achter*, and *naast*, an analysis was conducted per task.

3.5.1 Prepositions in the Linguistic Description Task

Adults interpreted prepositions other-centrally in the following proportions per preposition: *voor*: 33%, *achter*: 34%, *naast*: 25%. A Kruskal-Wallis test shows that the overall difference between other-centric interpretations between prepositions is not significant, $\chi^2(2)=3.379$, $p>.05$, with a mean rank score of 245.5 for *voor*, 248.5 for *achter*, and 227.5 for *naast*. Mann-Whitney U tests show that the differences between each pair of prepositions were also not significant: *voor-achter*: $U=12640.000$, $p>.05$, *voor-naast*: $U=11840.000$, $p>.05$, *achter-naast*: $U=11680.000$, $p>.05$. Children interpreted prepositions other-centrally in the following proportions per preposition: *voor*: 23%, *achter*: 21%, *naast*: 2%. A Kruskal-Wallis test shows that the overall difference between other-centric interpretations of prepositions is significant, $\chi^2(2)=25.159$, $p<.001$, with a mean rank score of 194.0 for *voor*, 191.0 for *achter*, and 156.5 for *naast*. Mann-Whitney U tests show that the differences between each pair of prepositions were as follows: *voor-achter*: $U=7080.000$, $p>.05$, *voor-naast*: $U=5700.000$, $p<.001$, *achter-naast*: $U=5820.000$, $p<.001$.

3.5.2 Prepositions in the Linguistic Instruction Task

Adults interpreted prepositions other-centrally in the following proportions per preposition: *voor*: 35%, *achter*: 35%, *naast*: 31%. A Kruskal-Wallis test shows that the overall difference in other-centric interpretations between prepositions is not significant, $\chi^2(2)=.914$, $p>.05$, with a mean rank of 244 for *voor*, 244 for *achter*, and 233.5 for *naast*. Mann-Whitney U tests show that differences between each pair of prepositions were also not significant: *voor-achter*: $U=12800.000$, $p>.05$, *voor-naast*: $U=12240.000$, $p>.05$, *achter-naast*: $U=12240.000$, $p>.05$. Children interpreted prepositions other-centrally in the following percentages per preposition: *voor*: 13%, *achter*: 15%, *naast*: 13%. A Kruskal-Wallis test shows that the overall difference between other-centric interpretations of prepositions is not significant, $\chi^2(2)=.330$, $p>.05$, with a mean rank of 180 for *voor*, 183 for *achter*, and 178.5 for *naast*. Mann-Whitney U tests show that the differences between each pair of prepositions were also not significant: *voor-achter*: $U=7080.000$, $p>.05$, *voor-naast*: $U=7140.000$, $p>.05$, *achter-naast*: $U=7020.000$, $p>.05$.

4. Discussion

The aim of this study was to investigate how children interpret projective locative prepositions in perspective-taking situations. In particular, we wanted to know whether children differ from adults in their perspective-taking behavior, whether interpretations differ in response to descriptions versus instructions, and whether different locative prepositions elicit different responses.

We found that adults interpreted locative prepositions other-centrally in about a third of the cases; in the remaining cases, they interpreted locative prepositions egocentrically. This shows a clear preference for an egocentric interpretation, which can be attributed to a strong egocentric bias (Epley et al., 2004). Children interpreted perspective-dependent locative prepositions other-centrally in about a sixth of the cases. Although this is less compared to adults, the difference between adults and children is not significant. One way to explain these findings is that 10-year-old children are already adult-like in their interpretation of projective locative prepositions. Another possibility is that differences between children and adults did not emerge in these tasks because the adults also strongly preferred an egocentric perspective. To resolve this issue, children should be compared to adults in a task that elicits mainly other-centric responses in adults.

Furthermore, our results show that adults do not interpret projective locative prepositions differently in descriptions compared to instructions. Apparently, there is no effect of the

communicative intention of the speaker (assertion or request) on the listener's interpretation of locative prepositions. Like adults, children did not show a difference in their interpretation of prepositions in descriptions versus instructions.

Zooming in on the prepositions used, children gave less other-centric responses for *naast* in descriptions, compared to *voor* and *achter*. A possible explanation is that children process *voor* and *achter* differently than *naast* (Vander Heyden et al., 2017). *Voor* and *achter* can be processed by rotating the position of objects (Level-1 perspective-taking), whereas *naast* requires a mental rotation to the perspective of the speaker (Level-2 perspective-taking), which is more difficult. The results of the Visual Perspective-Taking Task confirm this hypothesis, as most errors in this task were oriented errors, meaning that children were able to apply an object-rotation strategy to establish a correct front-back relation, but failed to perform a mental rotation strategy to establish a correct left-right relation. Another possible explanation could be that *naast* has a more complex meaning than *voor* and *achter* (cf. Zwarts and Gärdenfors, 2016). Interestingly, the difference between *naast* and *voor/achter* was only found for descriptions, and not for instructions. This suggests that, contrary to our expectations, instructions (and the associated speech act of request) may in fact make an other-centric interpretation of locative prepositions easier, perhaps because they require active involvement by the participant.

The aim of the study was to investigate whether participants interpret prepositions egocentrically or other-centrally. The expectation for pre-test items was that participants would take an egocentric perspective, because no other person was present in the scene whose perspective could be taken. However, we found that many participants took other perspectives than an egocentric relative perspective. For example, some participants (three adults and nine children) interpreted *in front of* as *left* and *behind* as *right* or the other way around, perhaps taking the direction of reading in Dutch as their RF. Other participants (thirteen children) interpreted *in front of* as being further away from the body than *behind*. Possibly, some of these interpretations were due to the two-dimensional presentation of the visual stimuli on the computer screen. If participants failed to interpret the two-dimensional presentation as a configuration in three-dimensional space, they could have interpreted *in front of* as *up* and *behind* as *under*. A future study may therefore include 3D visualization. Some of the objects in the pre-tests had an intrinsic front and back, such as a dress; however, only a few participants appeared to adopt an intrinsic RF. For a large group of participants (three adults and nineteen children) we could not determine which

RF they had applied. Probably this group switched between RFs.

Tversky and Hard (2009) found that adult speakers take the perspective of the listener in a quarter of the cases. We found that adult listeners take the perspective of the speaker in a third of the cases. An interesting issue for future study is whether the same people (a quarter to a third of the population) always take the other-centric perspective, either as speaker or as listener, or whether different people take an other-centric perspective at different moments. In both cases, misunderstandings are expected to occur on a regular basis, for example when a perspective-taker talks to a perspective-taker, or when a non-perspective taker talks to a non-perspective taker. Only when a non-perspective taker and a perspective taker talk to each other, no misunderstandings are expected. Thus, unless complementary cues are used that resolve the ambiguity in the use of locative prepositions, it remains a puzzle how this perspective-taking behavior contributes to successful communication.

In sum, adults and children interpret perspective-dependent locative prepositions both egocentrically and other-centrally, with the egocentric interpretation being the dominant response. The speaker's intention (assertion or request) does not affect this choice. In descriptions, children process *voor* ('in front of') and *achter* ('behind') differently from *naast* ('beside'), which might be explained by the fact that the former two prepositions require a different interpretational strategy than the latter one.

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